SYMEK Datensysteme und Elektronik GmbH

User Manual

For the Data-Transceiver

TRX4S

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SYMEK High-Speed Packet-Radio-Controller

The packet-radio-controller of the TNC3-family (TNC3S, TNC31) are capable to handle up to 1 Mbit/s data rate. Standard modems for 1200, 9600, 19200, 38400, 76800 and 153600 Baud are available. There exist special modems for mixed baudrates (e.g. TX 9600/RX38400) for satellite applications as UO-12 and others. The TNC3/31 is the optimal controller for use with the TRX4S data transceiver.

TNC3S: Dual port packet-controller (two independent modems), 256 Kbytes Flash-EPROM, max. 2 Mbytes CMOS-RAM, max. 1,6 Mbit/s total data rate. Software: Hostmode, Mailbox, KISS, SLIP, Hayes, Sixpack, X-Net.

TNC31S: Single port controller up to 1 Mbit/s. 128 or 512 Kbytes Flash-EPROM, max. 512 Kbytes CMOS-RAM. Software same as TNC3S.

Contents

PREFACE

Packet-Radio is usual with amateur radio since 1982. Starting with 1200 Baud data rate on 2m band, the standard today (1999) is 9600-Baud FSK (G3RUH).

With 1200 Baud AFSK, every radio could be connected by use of the microphone and speaker connector. For 9600 Baud FSK, most radios need to be modified. Modern fm transceivers offer a '9600 Baud capability'.

As those FM-transceivers had been designed for fm-speech operation, they are not ideally suited for packet-radio. Neither the receivers nor the transmitters are really optimised for data transmission and the delay between transmit and receive is far too long.

For a real data transceiver, the following facts need to be observed:

- Base band transmission and reception with a AF frequency range from 20 to 5000 Hz (9600 Baud) and 150 Hz to 80 kHz (153 kbaud) without distortion of amplitude or phase.
- The transmit-receive delay time must not take longer time as the transmission of approx. 50 bit of data. This is equivalent to 5 ms (9600 Baud) or 250 µs (153 kbaud).
- The if-bandwidth should be as wide as 30 kHz (for 19200 Baud) and 300 kHz (for 153 kbaud). The filters should be of the group-delay-optimised type..
- Simplex-operation (transmit and receive at the same frequency) must be possible without restrictions.

As these requirements are not met by any commercial available transceiver, SYMEK developed a special radio for high speed data transmission in the 435 MHz band. The TRX4S is not only a modified fm-speech-transceiver, but all parts had been developed new.

The development was mainly done by Gunter Kühnhardt, DC4SU (rf), Günter König, DG4SAS (microcontroller) and Ulf Kumm, DK9SJ (management, PCB-layout) in 1998 and 1999.

We succeeded in constructing a real data transceiver without restrictions in speed, power and delay.

We hope, you enjoy using the TRX4S.

The firmware of TRX4S may be updated or other versions may be available in future. You may order updates, which come together with a new manual. See our internet pages for announcement of new firmware releases.

This is the first English version of the TRX4S users manual. If you find any errors in the text, please inform us. We'd like to correct them immediately to give our customers the best documentation to our products possible. 21-Jun-1999 Ulf Kumm, DK9SJ

IMPORTANT: All information in this manual are valid only for the version TRX4S-C of the TRX4S printed circuit board and the firmware release 1.1.

INSTRUCTIONS FOR USE

Controls of TRX4S

If you have some experience with packet-radio, this side will give you all information required for operating TRX4S transceiver.

The TRX4S is operated with the cooler up.

LED-Displays, Front-panel Controls (from left to right)

REMOTE	connector for a remote control panel (see 'remote-control')
AUDIO:	volume (only effective for the AF amplifier / speaker connector)
SQUELCH:	squelch (only effective for the AF amplifier / speaker connector)
NARROW:	the transceiver runs in narrow mode (up to 19200 Baud)
RSSI DCD:	a rf signal is detected
RX:	the transceiver is in receive mode
TX:	the transceiver is on air (transmitting)
PWR:	power, the power supply of TRX4S is turned on (internal 5 volt)

Connectors (back panel) (from left to right)

ANT:	antenna, BNC-connector, 50 Ω, max. 30 Watt rf
Power supply	12 (13,8) Volt, max. ca. 6,5 A. red = positive, black = negative.
SPKR	speaker connector 8 Ω, 3,5 mm mono-jack, max. 0,5 W
Modem/TNC	data-connector for TNC, 6-pin mini-DIN-plug (see 'data connector')
RS232	interface to the computer, 9600 Baud, 8 Bit, NO Parity (see 'programming')

Channel Selection (local)

For selecting the frequency-channel you have to turn the TRX4S round (Cooler down).

On the right side between the RS232-connector (rear) and the remote-control connector you find a 7-segment LED-display and two 3 mm holes. With a appropriate pin, pushed through these holes, you can press two buttons inside of the TRX4S. to switch the channel number up and down. With an additional remote control unit, the same functions (up, down, display) are possible.

Set-up

In any case, you will have to program the desired frequencies into TRX4S EEPROM. Please see the chapter 'programming' and set all frequencies as needed. As default, channel No. 0 (TX = RX = 433,000 MHz, narrow, 3 Watt) is programmed.

PROGRAMMING

Connection of the Interface

Use the interface cable supplied with the TRX4S and plug it to the 9 pin connector at the serial COM-interface of your computer.. (COM1 or COM2). If your computer has a 25 pin male connector instead of a 9 pin, you may use a standard adapter (25 pin female to 9 pin male) .

The rs232-interface and connector of TRX4S is compatible to the TNC31 connector. The baudrate is fixed to 9600 baud.

If you like to make your own interface cable, please read the detailed description on page 15.

Operation with the program TRX4TERM.exe

On the disc, you find the program 'TRX4TERM.exe'. By use of this program you can do all settings of the transceivers. The program is started from dos or window and is fully self-explaining. Prerequisite for using TRX4TERM is the proper connection of the TRX4S to one of the serial ports COM1 or COM2 of the computer. The program will check if a TRX4S with the proper firmware is connected to one of the two COM-ports. Connection of two TRX4S at COM1 and COM2 at the same time is possible. The hardware-handshake of the COM interfaces have to be fully wired, it is not sufficient to connect only TxD, RxD and ground. (see page 15). Important: do not start TRX4TERM if one of the com-ports is busy with another (terminal-) program.

With TRX4TERM, you can do the following settings:

- check and set the current channel number.
- read and set all frequencies, power and mode
- read the s-meter and display it as bar graph
- read the temperature (or output power) and display it as bar graph
- read the firmware-version number and serial number of the transceiver
- read, store and write the EEPROM contents
- calibration of temperature, signal strength and power reading

Do not switch off the transceiver when the TRX4TERM program is running.

Operation using a terminal program

For all settings of TRX4S, you may use a standard terminal program instead of TRX4TERM as well.

The serial (rs232) interface (COM-port) of your PC has to configured as follows:

baudrate:	9600
parity:	N (none)
bits/character	8
Xon/Xoff, protocol:	off
RTX/CTS handshake:	off
stop bits:	1

How to set these parameters depends on the program used. On the supplied disc, you find a simple program 'TERM', which can be used for TRX4S without further configuration. For Atari you can use the VT52-emulator on the accessory disc..

Connect the TRX4S to the serial (com) port of your computer and run TERM (simply directly from the disc). TERM is ready configured to use COM1 as serial port. To use it with COM2, press ALT-P, E, 2, <return>, <escape>. This setting can be stored by pressing R before <return>. Otherwise, TERM will use COM1 when started again.

Now switch power of TRX4S on. The transceiver will prompt:

K0=0433.0000 N 1 0433.0000

If this or a similar line is displayed, the interface works perfectly. Type:

VERS

The transceiver replies with the version number of the firmware, e.g.

SYMEK TRX4S CPU4 V1.1

The communication between terminal and transceiver is now completely checked.

Programming the channels

The TRX4S can store 16 channels. With the up and down keys at the transceiver you may select the channels. The led-display shows the channel number in hexadecimal, i.e. the figures appear in the sequence

0 1 2 3 4 5 6 7 8 9 A B C D E F 0 1...

Future versions of TRX4S may be reduced to 10 channels.

With a PC and a terminal program (called 'terminal') you can now set the channels. . We recommend the program TERM (dos), Terminal.exe (Windows 3.11), Hyperterm (Windows95 and Windows98) or any other terminal program (Telix etc.). Of course, you can use other computers (Atari, Amiga, Apple etc.) as well.

The setting uses short records, containing exactly 26 characters e.g.

Z0=0433.2500 N 2 0433.5125

This record contains the following information: :

Z0=	command: the line will be stored in EEPROM as channel 0 setting.
0433,2500	transmit frequency in MHz
N	mode of operation for transmitter and receiver: N = narrow, W = wide
2	programmed transmit power level 2 (6 Watt)
0433.5125	receive frequency in MHz

Program now all settings for the channels 0 to F.

If this programming shall be made automatically (by a software program), there has to be a guard time of 250 ms after each line. after the next record may be sent. The TRX4S will need this wait time for storing the received information into EEPROM.

Selecting the channels (up/down keys)

With the up and down keys, you can select one of the 16 stored channels as the current channel. . The current channel will be shown oh the 7-segment display. The number of the current channel is stored immediately.

At power-on of the transceivers, the current channel at last power-off is set automatically. . So, it is made sure that no settings are changed when cycling power.

When pressing the 'up'-key‘, the channel number is incremented by 1. After 'F', the number changes to '0' again. So, the use of the 'down'-key is not imperative.

The 'up' and 'down' keys may be accessed through the 3.1 mm holes near the led-display in the aluminium bottom panel of TRX4S. Use a 3 mm pin or screw to press the key inside the transceiver. If the display is on top and located to the right hand (connectors rear, controls front), the upper key is the 'up' and the lower (towards front side) is the 'down' key. It is sufficient to access only one of the two keys: pressing 15 times 'up' has the same effect as pressing 'down' once.

CONNECTORS

Connector for modem or TNC

On the rear side of TRX4S you find a 6-pin mini-DIN-connector. for connection of a packet-radio-controllers (TNC) or other modems. The pins are assigned as follows:

Pin 1: modulator, output of TNC

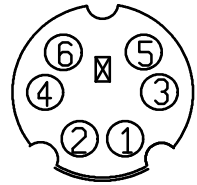
Pin 2: ground

Pin 3: PTT

Pin 4: data, input of TNC

Pin 5: +10 volt (current limited)

Pin 6: RSSI-DCD output



6-pin Mini-DIN connector,

outside view to the case

Cable between TRX4S and TNC

The wiring of all 5-pin DIN connectors of SYMEK TNC is the same:

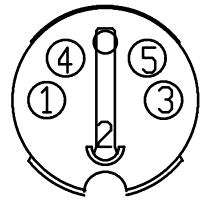
Pin 1: modulator, output of TNC

Pin 2: ground

Pin 3: PTT

Pin 4: data, input of TNC

Pin 5: not connected



5-pin DIN-connector at TNC

The cable between TNC and TRX4S has to be as follows: :

TRX4S 6-pin mini-DIN	Signal	TNC 5-pin DIN
Pin 1	modulation	Pin 1
Pin 2	ground	Pin 2
Pin 3	PTT	Pin 3
Pin 4	demodulator	Pin 4
Pin 5	RSSI-DCD	N.C.
Pin 6	+10 V	N.C.

Signals from and to the modem

Description of the inputs and outputs of the data connector of TRX4S. All signals refer to ground (Pin 2).

Modulation-input (Data in) Pin 1

Here, the data output of the modem is connected. The radio is adjusted, that the proper modulation deviation is reached at 0.5 volt (peak to peak) modulating voltage. (equals 180 mV_{eff} (effective). This is valid for 9600/19200 baud narrow as well as for 76/153 kbaud wide band mode. The deviation can be adjusted with trimmers inside the TRX4S, but we recommend to adjust the proper output level at the modem.

The input impedance of TRX4S is 22 kΩ. If you have capacitors in series with this input, make sure they have a capacity of 22 µF or more. Otherwise, the low frequencies are not properly modulated.

The input is free from dc, so an additional coupling capacitor is not necessary and even disadvantageous. The dc voltage across the modulation input may vary from –5 to +5 volt. If higher voltages are present, connect a additional capacitor in series.

The frequency range of the modulating signal reaches from 5 to 10000 Hz (narrow mode) and from 50 Hz to 90 kHz (wideband mode). The spectrum outside this range is suppressed by the modulation amplifier. The lowpass filters are switched automatically according to the wide/narrow selection.

Receiver output (Data out) Pin 4

The TRX4S uses two different if amplifiers and demodulators for narrow and wideband operation. According to the setting, one of these two outputs is switched to pin 4 (data out) of the modem connector.

The demodulator-outputs are buffered by a lowpass amplifier and have a very low output impedance. The output resistance is 220Ω in series with a 22 µF capacitor. With an external load of 1 kΩ this results in a low corner frequency of approximately 10 Hz. Do not connect a modem with lower impedance or add capacitors in series. Otherwise the output bandwidth would be reduced.

The output is dc-free and decoupled by a capacitor. A external dc voltage of –5 to +5 volt may be applied.

The frequency range of the output signal goes from few Hz up to 30 kHz (narrow) or from 50 Hz to 100 kHz (wide band mode). (with high impedance load)

The output voltage depends on the deviation of the received signals and is approximately 0,5 $volt_{pp}$ (peak to peak) (180 mV_{eff} (RMS) and cannot be changed / adjusted.

Transmitter keying (PTT) Pin 3

The PTT-pin shows + 5 Volt when receiving (open circuit). If it is pulled to ground (by the modem or by a switch), the transceiver starts transmitting immediately.

To keep the time from PTT-line going low to transmitting short, this input should be pulled directly to ground without series resistors. . The transmitter is keyed as soon as the voltage at pin 3 goes below 2 volt. The pull-up-resistor to 5 volt has a value of 47 kΩ. A low pass against radio-frequency interference with 200 kHz corner frequency is built-in.

Carrier signal detection output (RSSI-DCD) Pin 6

As soon as the rf input signal at the antenna input of TRX4S exceeds an adjustable level, the green DCD led at the front of TRX4S lights. Simultaneously, pin 6 of the modem connector is pulled to ground (low).

The rf signal level, at which the RSSI-DCD reacts, may be adjusted by two separate trimmers for narrow and wide mode inside the TRX4S. The trimmer are pre-adjusted for detection of signals

exceeding 0,5 µV antenna input voltage in narrow and wideband mode. Note: If much noise is present at the receiver input (QRM, QRN or by additional noise of a preamplifier), the trigger level of RSSI-DCD has to be adjusted to higher levels.

The output is an open collector output, capable to switch up to 16 mA to ground. The maximal permissible voltage is 30 Volt. Caution: this output is not protected against overload.

10 volt external supply (+10V) Pin 5

For supply of external low power circuitry, the internal 10 volt supply is present at pin 6 of the 6 pin mini-DIN connector. To avoid damage by overload or short circuit, a resistor of 600 Ω is in series with the output. So, the current drawn is limited to few mA. A microphone amplifier or similar circuitry may be supplied from this output without problems.

Avoid permanent short circuit of the output. The short circuit current is 10v / 600Ω = 16 mA.

Remote-Control connector'

Here, you may connect a remote control circuitry. The following control functions are accessible via this connector:

- power supply (ground, +5 volt)
- serial interface (5-Volt RS232) for remote control
- up and down keys
- 3-wire interface for 7-segment-display and mode display (power, narrow/wide)
- 12,800 000 MHz ttl output of the reference oscillator

Power supply, fuses

The power is applied via the 2 wire cable, supplied with the TRX4S. The 2 pin connector is a standard AMP universal mate-n-lok no. 350777 type, the 2 pin plug for the cable is used with two female crimp contacts AMP Mate-N-Lok No. Type 163306-4. The connector is good for up to 25 amp and cannot be reversed in polarity.

The 12v dc power must not be reversed in polarity. If the power is applied with the wrong polarity, a fuse inside the TRX4S will blow and has to be replaced.

For replacement, use only a 6,3 A fuse (20 x 5 mm) with medium fast characteristic. Never short circuit the fuse by a wire. Never use higher current types. The fuse is found directly near the power inlet and can be easily accessed by opening the TRX4S bottom cover. Take care not to damage the speaker wires when opening the case.

To make sure that there is no voltage drop on the supply cable, you have to use wires with sufficient diameter. With only 0,1 Ω total resistance of the supply cable, there would be already a significant voltage drop of 0,5 volt, but the maximum output power is only possible with 13,0 volt supply across the power input of the TRX4S.

Inside the TRX4S, there is a low-ESR electrolytic capacitor with 180 µF, which cannot work a smoothing capacitor for low quality power supplies. . The power source has to supply 13.5 Volt with permanent 6 A and 8 A peak current. The low-cost CB-radio power supplies with so-called '6/8 A power capability' will quickly overheat, when the transmit/receive ratio exceeds 20%. In many cases, the open circuit voltage of those power adapters exceeds 15 v. The ac filtering / smoothing of the output voltage is not perfect, which causes in 100 Hz amplitude modulation of the fm carrier. The power supplies designed for amateur radio transceivers (13,5V 12A) have much more power reserve and are well suited for use with TRX4S even when transmitting for longer time. Of course, you may use a car battery for supplying the TRX4S. Take care to use wires with adequate cross-section. .

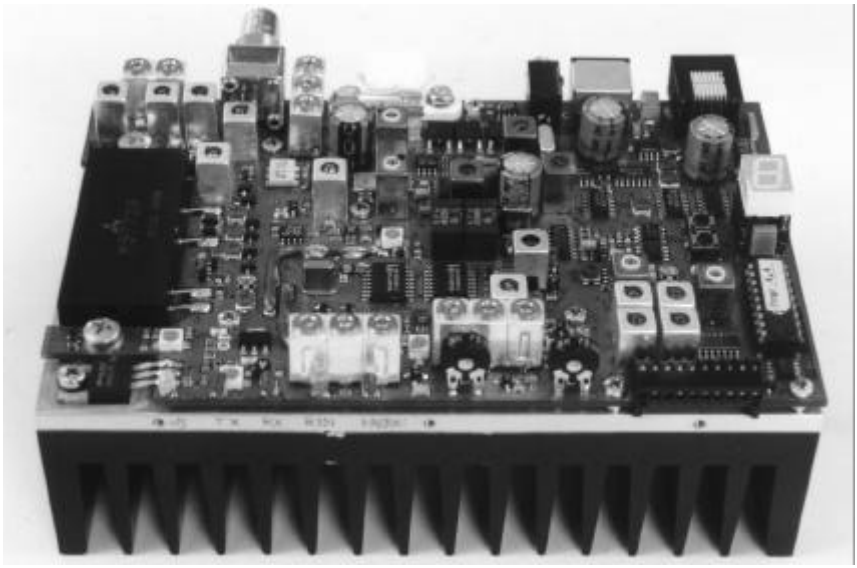
Operating hints

TX-Delay setting

The real TX-delay of TRX4S is 1 ms or less. Watch the following points when setting the parameter 'T' at your TNC:

- TNC: the extremely short delay-time cannot be programmed with most of the packet-radio-controllers available today (1999). With TNC2H or other TNC2 (Z80) derived TNC, the TX-delay can be programmed in multiples of 10 ms only. T 0 is always too short, T 1 means already 10 ms delay and is much too long. The TNC3 allows programming the TX-delay in 1 ms steps. In addition, a TX-delay of 0 can be set and a preamble of up to 16 flags may replace the T setting and gives a delay, which is proportional to the baudrate. (TNC3-Firmware 1.8 and later).
- partner station: when setting the transmit-delay you have to observe, that this time is not only required for your own transmitter to start operating but also for the receiver of the station, you are in contact with for switching off its the transmitter completely, switching on its receiver up to full sensitivity and getting its receiving modem synchronised. If you work with a simplex digipeater which needs 50 ms to switch from transmit to receive, you have to consider this. If not, the remote receiver will loose the fast answers from your TNC and has to wait for a repeated transmission. The remote station will show all your packets in monitor mode except the first one, which came too early.
- The transmit filter of a G3RUH-modems needs some bit preamble until valid data is sent. The receiver of those modems needs some clock cycles as well to synchronise and lock the clock recovery circuit. Those delays depend on the baudrate and become shorter as baudrate rise.

Recommendation: With TNC2H and TNC3/TNC31 the minimum TX-delay of T 1 can be set. If there is a problem, check if the slow receiver of the remote station is the cause and increase TX-delay until the problem disappears.



TECHNICAL DESCRIPTION

Technical data of TRX4S (valid for 1999 version C of printed circuit board)

Dimensions: without case, without cooler: W= 163 mm, D= 103 mm, H= 29 mm, weight 0,5 kg.
Without case, with cooler: W=163 mm, D=103 mm, H=70 mm, weight 1,5 kg

Power supply: 12 volt dc (11...16 V) reception: 250 mA; transmit max. 6 A,
2-pin AMP receptacle. Fuse 6,3A slow inside the case (fuse 20x5 mm). 13 v required for full transmit power of 25 watts. Typical values at 12,5 v :
RX: 0,27A; TX 3 W: 2,2 A; TX 6 W: 2,6 A, TX 12 W: 3,5 A; TX 20 W: 5,0 A.

Frequency range: Standard adjustment: 430 - 440 MHz

Frequency drift / error: typ. ± 2 PPM (= ± 1 kHz), max. ± 5 PPM (= ± 2,5 kHz),

Channel spacing: 12,5 kHz

Temperature range: 0 to 50 C.

Programming: via rs232-serial interface (9600 Baud, 8 Bit, NO Parity), 8-pin RJ45 receptacle. For every channel, the transmit frequency, receive frequency, transmit power and mode may be defined and stored. Reading of signal strength in dBm and temperature is possible. Connection of a remote control unit is possible.

Frequency setting: any 16 frequencies may be programmed and stored in TRX4S. Selection with up-down buttons inside the transceiver. 7-segment channel display.

Over-temperature protect: transmitter will be disabled above 60 to 65 C temperature of the power amplifier.

Reference oscillator: 12,800 MHz ± 5 PPM

Antenna switch: 3 power pin diodes.

Useful packet data rate: max. approx. 50 packets (256 Bytes each) or 100 packets (100 Bytes each) per second.

Receiver:

Sensitivity: 0,2 µV at 50 Ω (12 dB SINAD, narrow-mode)
Maximum input signal: without destroying the input:
in band (430-440 MHz): +13 dBm = 20 mW = 1 v rf voltage
< 400 MHz, > 470 MHz: +33 dBm = 2 Watt = 10 Volt rf voltage
Audio amplifier: 0,5 W at 8 Ω, 3,5 mm speaker jack,
built in miniature speaker. The speaker is not disabled when transmitting.
So, the transmitted signal can be heard (simplex mode)
Data-output: 0,5 $volt_{pp}$, low impedance, 6-pin mini-DIN-connector
Mirror frequency suppression: 506 MHz and 364 MHz: >70 dB
Signal detection (rf-DCD): two (narrow/wide) separately adjustable
triggers show if a rf signal is present. **RX-on-delay**: Delay from 'PTT = high' until reception: < 2 µs
Wideband mode:
selectivity: ± 300 kHz: >60 dB, stop band: >110 dB
AF-bandwidth: 50 Hz to 80 kHz
dynamic range: -120 dBm = 0,2 µV to –40 dBm = 2 mV
Narrow mode:

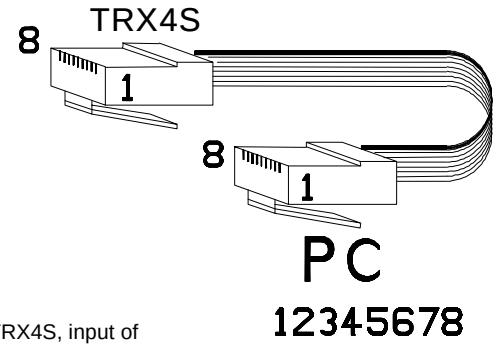
selectivity: ± 35 kHz: >90 dB, stop band: >110 dB
AF-bandwidth: 10 Hz to 10 kHz
dynamic range: -125 dBm = 0,1 µV to –50 dBm = 1 mV

Transmitter:

Output power: programmable 3/6/12/25 watt at 50Ω
(with supply voltage below 13 v only 20 watt)
Efficiency: typ. 5,5 A / 13 V = 75 watt input at 25 w output. η= 35 %
Duty cycle: depending on ambient temperature and cooling conditions,
a average transmitter power of 12 watt (25 Watt at 50% duty cycle) is allowed. Permanent (100%) transmission at full power requires forced air cooling. (fan))
Power regulation: the output power is kept constant to ±0,2 dB within the total frequency range
Mod-input: 0,5 $Volt_{pp}$ at 22 kΩ, separate low pass amplifiers for wide and narrow mode
Wideband mode: audio bandwidth: 30 Hz to 80 kHz, TX-delay (PTT low to full output power – 1 dB): 50 µs
Narrow mode: audio bandwidth: 5 Hz to 15 kHz, TX-delay: 100 µs
Carrier suppression at the transmit frequency when in receive mode: infinite, no spurious signal present.
Harmonic and spurious signal suppression: below -70 dB(c)
Transient emissions: at keying with 10 Hz: (50 ms TX, 50 ms RX): <- 40 dB (adjacent channel), <-50 dB (500 kHz from carrier), <-60 dB (2 MHz distance), referred to carrier and channel bandwidth (wide).

Interface cable for serial rs232 interface

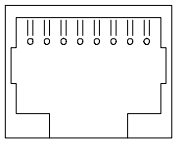
The serial cable to the computer supplied with TRX4S. . You plug it into the 9 pin male connector of the PC. The cables and connections are the same as used with TNC31S.



For serial (rs232) interfaces, modern computers uses the small 8 pin rj45 connectors instead of the bulky 25 pin sub-d types. Cables and adapters are available in most computer-hardware shops everywhere. Here some explanation to this new technique:

rj45 pin 3 = transmit data from TRX4S to computer, output of the TRX4S
rj45 pin 6 = transmit data from the computer to TRX4S, input of TRX4S
rj45 pins 4+5 = common ground

As the rj45 connector is not soldered to a cable but fixed by using a special tool, the cable cannot be made by hand. But there are inexpensive ready made cables available in every computer shop. They are called 'ISDN-cable' available screened or without screening. (ISDN S0 bus cable for German ISDN standard wall outlets.). For expansion of the cable length, there are small adapters available with a female contact at each end. Sometimes, the cables have only 4 or 6 of the 8 pins wired. This is no disadvantage, as the TRX4S uses only the centre 4 pins no. 345 and 6. The outer pins 1,2,7 and 8 are not connected.



RJ-Connector, rear view. Only pins 3,4,5 and 6 are used

The cables are available as: 8-wire flat cable / modular-cable with rj45 connector, ISDN-cable rj45, patch cable 1:1 connected, cable with 8 pin western-connectors. If you find similar cables with smaller 6 or 4 pin connectors, as used with other telephone applications, you may use them as well. Screened cables are much more expensive, but provide better suppression of radio interference.

The both connectors are mounted in a way, that the latches of the connectors are on the opposite sides of the (flat) cable. So, the sequence of the pins remain unchanged (see picture).

Caution: There exists cables with so-called 'roll-over-connection'. With those cables, pin 1 is connected with pin 8, pin 2 with Pin 7 etc. Since introduction of ISDN, those roll-over cables are unusual.

With the PC serial interface COM1 there is in most cases a 9 pin male connector found at the rear of the computer. For COM2, you will find also a 9 pin or in many cases a 25 pin male connector. When using COM1 to connect your mouse, you will use perhaps COM2 for the TRX4S. To connect the modular cable with the rj45, you need the adapter supplied with the transceiver. Here the list which describes how to built such an adapter. (RJ-connector as shown in the picture, view the adapter from the rear side.):

1) rj45 pin 3 (black wire) goes to sub-d 9 pin 2 (or sub-d 25 pin 3) Signal: RxD from TRX4S to PC.
2) rj45 pin 4 (red wire) goes to sub-d 9 pin 5 (or sub-d 25 pin 7) Signal: ground
3) rj45 pin 6 (yellow wire) goes to sub-d 9 pin 3 (or sub-d 25 pin 2) Signal: TxD from PC to TRX4S.
4) cut the remaining wires directly at the rj45 connector (pins 1= blue, 2= orange, 5= green, 7= brown and 8= white/grey. You will need them for wiring the hardware handshake lines of sub-d connector.
5) click all 8 wires into the sub-d connector body. Caution: as soon as you hear the 'click', the jack cannot be removed again.
5a) For 9 pin female sub-d, you put green in pin 1, black in 2, yellow in 3, grey/white in 4, red in 5, brown in 6, blue in 7 and orange in 8. 9 remains empty.
5b) For 25 pin female sub-d, you put yellow in 2, black in 3, orange in 4, blue in 5, brown in 6, red in 7, green in 8 and white/grey in 20. All others remain empty.
6) short circuit the hardware handshake by removing the insulation of the 5 open ended wires and solder the blue and orange wires together.
7) solder the brown, green and grey/white wires together.
8) use heat shrink tube to insulate the bare wire joints and complete the adapter by closing the case. Make sure, the rj45 block is completely latched in the adapter case.

Terminal-programs (set-up)

The serial interface (COM) of PC has to be set up as follows:

baudrate:	9600
parity:	N (none)
bits/character:	8
Xon/Xoff, protocol:	off
RTS/CTS handshake:	off
stop bits:	1

How to set these parameters depends on your terminal program. In most cases, the setting is stored in a configuration file and restored automatically when starting the program.

Configuration of TERM 10.36 (ms-dos program by DL5FBD)

On the disc, which is supplied with TRX4S, you find a simple terminal program TERM.exe, and the corresponding configuration file TERM.cfg. You may run the program directly from the disc. It uses (with the term.cfg) the following settings:

COM-Port	e	1
baudrate	g	9600
word length (Wortlänge)	h	8
parity (Parität)	i	K (keine)
stop bits	j	1
handshake	k	K (kein)
duplex (echo)	l	H (Halbduplex, Echo ON)
character guard time (Zeichenschutzzeit)	u	25 ms
linefeed guard time (Zeilenschutzzeit)	v	250 ms

With the ALT-P key, the configuration may be changed easily. With the r key, the changed settings may be stored in term.cfg permanently. It has been found, that the program behaves somewhat different with linefeed on different computers.

Configuration of 'Terminal' (Windows 3.11)

With Windows 3.11 comes a terminal program called simply 'Terminal'. Find it on your hard-disk as C:\Windows\Terminal.exe and execute the following settings: (maybe the English version of Windows Terminal uses other expressions as I expect)

1. menu 'settings – data transfer is set to COM2, 9600 baud, 8 bit, no parity, no protocol, 1 stop bit.
2. menu 'settings' – text transfer is set to 'transfer line by line' with 3/10 sec linefeed guard time / line delay.
3. menu settings – terminal-emulation is set to e.g. TTY-general
4. menu 'settings' – terminal-settings activate the local echo.

The settings are stored as a .trm file, e.g. TRX4S.trm. This file will be found in C:\Windows\ and can be dragged and dropped on the desktop in any program group of Windows 3.11. Double-clicking the icon (labelled TRX4S), will immediately start 'Terminal' with the proper configuration.

Configuration of Hyperterm (Windows95/98)

With Windows 95/98 comes a fine new terminal program called 'Hyperterm'. You can start it in programs – accessories – communication – Hyperterm with the following settings: (referred to the German version of Hyperterm)

1. When starting, Hyperterm asks for some prefix-number. Type any number you like.
2. The program asks 'new connect?'? Type e.g. TRX4S and select one of the funny icons.
3. In the window 'connect via' “ you select the COM-Port, e.g. COM2 - OK
4. As 'communication settings' you select 9600 baud, 8 data bits, no parity, 1 stop bit, no protocol. OK
5. With 'file - characteristic - settings you may set the ASCII-configuration : Switch on the options 'transmitted lines end with linefeed' and 'echo input characters locally (local echo). A linefeed delay (guard time) of 250 milliseconds is recommended, the ASCII-settings remain unchanged.
6. The settings are stored. The file TRX4S.ht, which contains the settings, can be found normally in C: \programs\accessories\hyperterminal and may be drag-and dropped onto the desktop. As soon as the symbol with the label TRX4S is clicked or double clicked, Hyperterm will start with the correct settings.

With Windows98 and Hyperterm, we did not succeed in switching the local echo on. With Windows95 there was no problem.

Commands of the TRX4S firmware 1.1

The TRX4S contains a microcontroller, which communicates with the PC by a serial rs232 interface. The commands, which are understood by the microcontroller are explained here. Every line has to end with a return-character ($13). The number and position of the characters within a command string has to match exactly as described here.

Designations:

n channel identifier {0, 1, 2, 3, ... 8, 9, A, B, C, D, E, F}

T, R decimal figure for transmit (T) and receive (R) -frequency {0, 1, 2, 3, ... 8, 9}

F operating mode: N = narrow, all others = wide {N, W}

P transmit output power: 4=25 watt, 3=12 watt, 2=6 watt, other: 3 watt, {1,2,3,4}

the remaining characters (Z, K, S, R, V and the decimal point) must be used exactly as indicated.

Storing a record

With this command, a channel data record is stored in EEPROM of TRX4S. After the command has been executed, the record is read out immediately and returned as acknowledgement to the PC.

input: ***Zn=TTTT.TTTT F P RRRR.RRRR***

reply: ***Zn=TTTT.TTTT F P RRRR.RRRR***

Note: the records are not checked for proper syntax. Wrong and nonsense characters after the '=' are stored as given. This may cause unwanted and unexpected settings of the transceiver when selecting the channel later. In most cases, the wrong frequency setting causes the PLL oscillator not to lock. If the 'transmit'-led remains off when keying the transceiver, in most cases a wrong programmed channel record is the cause. The same is true for the receiver ('receive'-led doesn't light).

Note: The Z-command changes the contents of the frequency memory, but does not change the current frequency and mode of the transceiver.The new frequency becomes not valid until the channel n (via remote command or by pressing up/down keys or at power-on) is selected again.

Reading a record

With this command, a channel data record may be read out of the TRX4S EEPROM.

input: ***Zn=?***

reply: ***Zn=TTTT.TTTT F P RRRR.RRRR***

Reading all 16 records

With this command, a listing of all 16 channel data records is read out of TRX4S-EEPROM.

This command is executed automatically, when the 'up' key is pressed at power-on.

input: **ZX=?**

reply: **Z0=*TTTT.TTTT F P RRRR.RRRR***

etc. until

ZF=*TTTT.TTTT F P RRRR.RRRR*

after each line, there is a short delay of 250 ms.

Note: If the frequency of a channel had been changed before with the Z-command, the result of the ZX=? command will change as well. BUT the real frequency and mode settings remain unchanged until the current channel is selected again (see above).

Selecting the current channel

With this command, one of the 16 possible channels is selected to be the current channel. . The channel-number-display, the transmit and receive frequency, mode and power are changed according to the newly selected channel. The number of the channel is stored immediately.

The command has the same effect as changing the current channel by pressing the up and down keys.

input: **KX=*n***

reply: **K*n*=*TTTT.TTTT F P RRRR.RRRR***

Reading the current channel-number

With this command, the number of the current channel is read out:

input: **KX=?** reply: **KX=*n***

Reading the s-meter (signal strength)

The antenna rf input voltage is read in dB with reference to 1 mW. (dBm). The calculation of the displayed value in dBm and the internal measurement uses a lookup-table, stored in EEPROM. There exists two separate tables for narrow and wide mode, as the RSSI-voltages are derived from two different if-demodulators for each mode. The minus-sign is omitted, so a display of 90 means -90 dBm.

input: **R0=?** reply: **R0=DDD**

Temperature display (output power)

The temperature of the transmitter power amplifier is measured by a sensor and can be checked via the serial interface. The temperature is displayed directly in degree Celsius. The calculation of the displayed value in Celsius and the internal measurement uses a lookup-table, stored in EEPROM. . By changing this table, it is possible to change the reading to Fahrenheit or other units, however the displayed values have to be in the range of 0 to 255. The pins M830-M831 has to be connected by a 100 kΩ resistor for temperature measurement.

input: **S0=?** reply: **S0=DDD**

The S0= command will immediately read the actual temperature value, converted in Celsius. This value may, caused by the coarse resolution of the A/D converter, show steps of 3 to 5 degree. For more accurate measurements, you should make 10 or 100 readings and calculate the average value. This makes the reading slower but quite exact. In TRX4S terminal program TRX4TERM, there is a floating average value calculated: The most recent reading contributes only 1 % to the result, the contribution of the old readings is 99%.

Optional: If the pins M831-M832 are connected by a 100 kΩ resistor, you can measure the transmitter output power instead of temperature. . Problem: As the transmitter is not keyed permanently, you will read 0 watt while receiving. The transmit power can be displayed in dBm, the calculation of the displayed value in dBm and the internal measurement uses a lookup-table, stored in EEPROM. There are two tables in EEPROM: one for temperature measurement (0400H-04FFH) and one for power measurement (0300H-03FFH). Which of the tables is used depends on the value of a switch variable in EEPROM. (See EEPROM-programming).

Display firmware-version number

input: **VERS**

reply e.g.: **SYMEK TRX4S CPU4 V1.1**

Show serial number

In the TRX4S, a serial number and the date of manufacture are stored. Please do not alter this data, it won't be possible to change the values without knowledge of the proper algorithm code. The memory, where the data is stored, cannot be written by the program TRX4TERM. When starting TRX4TERM, the serial number is read and displayed.

Error messages of TRX4S, syntax

The TRX4S uses only the lower 7 bit of all input characters. Lowercase characters (from 60H to 7BH) are converted to uppercase by subtraction of 20H. .

The data input is not checked completely for correct syntax:

- The content of a channel-data record ***DDDD.DDDD F P DDDD.DDDD*** is not checked. You may input any nonsense, which will result in wrong and unexpected results later.
- The commands are not checked completely. The microcontroller checks only if the command is unequivocal, e.g. the version display command ***VERS*** will be caused by all inputs starting with V and having a length of 4 characters, so you may type ***VOLT*** or ***V0=?*** with the same result.
- The mode is set to 'narrow' only when a ***N*** or ***n*** is given in the channel record string. All other figures are interpreted as wideband mode commands.
- The output power is defined with the figures 2, 3 and 4. All other characters are interpreted a 1 (lowest power setting) within the channel record string.
- The decimal point is not interpreted. Any other character or the comma are allowed as well. The TRX4S interprets only the least significant bits of the figures of the frequencies. The input ***430,25000*** instead of ***0430,2500*** not correct. It will not cause an error but leads to an unwanted result.

The following input errors are recognised: :

ERROR 1 Line length over 27 characters
ERROR 2 Command line length has not exactly 4 characters length
ERROR 3 Unknown command with 4 characters length (not Z, V, S, R, K as first character)
ERROR 4 Unknown command string with 27 characters length (Z is not the first character)
ERROR 5 EEPROM address or EEPROM-byte no correct hexadecimal code
ERROR 6 EEPROM address exceeds 07FFH

SERVICE-ADJUSTMENTS

Programming of EEPROM-memory

The EEPROM contains a list with the records for the 16 channels, information about the last selected channel number, four lookup-tables for conversion of s-meter and temperature measurement and a flag for switching the temperature and output power tables.

The records containing the channel frequency information should be written with the normal user command ***Zn=***... , the lookup-tables should remain unchanged.

For special applications it is possible to access the EEPROM directly, e.g. for the first set-up. There exists a command for writing every byte into each address of EEPROM..

Definition:	**XXXX**	EEPROM-address (hexadecimal) value range: {0000 to 07FF}
	YY	EEPROM-data (1 byte, hexadecimal) value range: {00 to FF}

POKE: write byte to EEPROM

command:	**XXXX YY**	YY will be stored at address XXXX of EEPROM.
reply:	**XXXX YY**	contents of address XXXX is YY.

PEEK: read byte in EEPROM

command:	**XXXX**	read address XXXX of EEPROM.
reply:	**XXXX YY**	contents of address XXXX is YY.

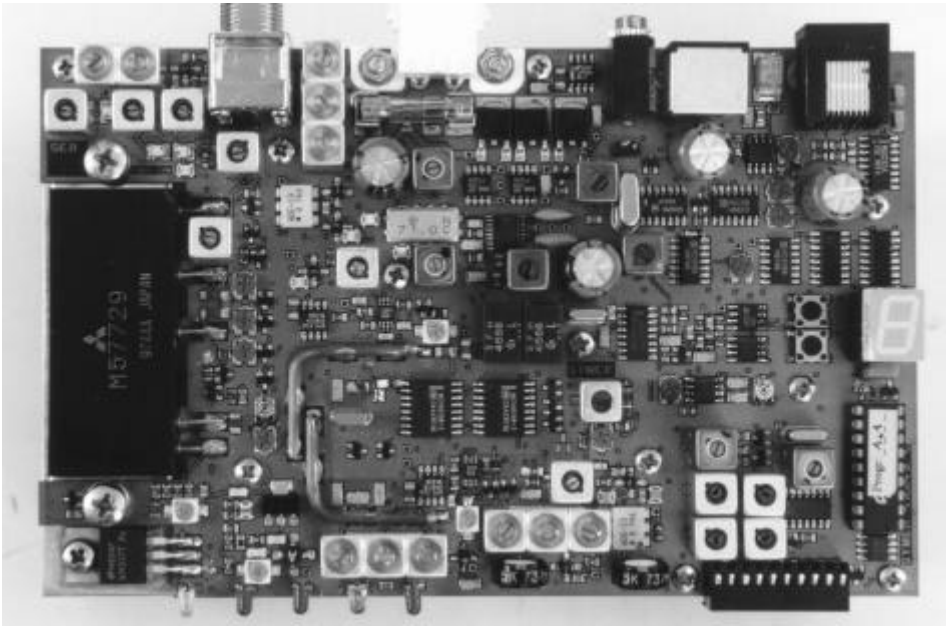
EEPROM memory map

Address	decimal	description
0000...0017	(0-23)	24 Byte ASCII chan. 0 e.g. "**0433.7000 N 2 0433.7000**"
0018...002F	(24-47)	24 Byte ASCII chan. 1 e.g. "**0434.2125 W 2 0434.2125**"
etc. until		
0168...017F	(360-383)	24 Byte ASCII chan. F e.g. "**0433.7000 N 2 0433.7000**"
0180	(384)	number of the channel, which was selected last (00 to 0F)
0181	(385)	table select: (00= temperature or 01= power table is used)
0182...01FF	(386-511)	manufacturer's information etc. do not alter!.
0200...02FF	(512-767)	conversion-table for meter, narrow mode
0300...03FF	(768-1023)	conversion-table for meter, wide mode
0400...04FF	(1024-1279)	conversion table for power/temperature, used when (0181H=01H)
0500...05FF	(1280-1535)	conversion table for power/temperature, used when (0181H=00H)
0600...07FF	(1536-2048)	free memory space, may be used by external software.

Useful formulas (see page 46): (Z_0=50 Ω, U_{in} = voltage across Z_0 in volt, P_{dBm} = power in dBm)

$$U_{in} = \sqrt{Z_0 \cdot 1mW \cdot 10^{\frac{P_{dBm}}{10}}} \quad ; \quad P_{dBm} = 10 \cdot \log\left(\frac{U_{in}^2}{Z_0 \cdot 1mW}\right) \quad ; \quad \log(x) = \frac{\ln(x)}{\ln(10)}$$

INTERNAL ADJUSTMENTS



Opening the case

Before one of the following adjustments is done, you have to open the TRX4S case first. Locate the case bottom up (cooler down) and loosen all 10 screws of the bottom plate (which is now oriented towards you with speaker and display), do not totally remove the screws. Gently pull the cover up by using the screws as handle. If the cover is very tight, loosen also the screws at the top panel.

The loudspeaker is fixed at the bottom plate. Take care not to destroy the speaker cable. . The speaker wires can be disconnected near the external speaker connector.

The big heatsink can be removed. Just remove the six screws with a hex driver. Caution: use the same screws and all washers when reinstalling the heatsink. The screws must not intrude more than exactly 5 mm into the transceiver's base plate. A shorter intrusion length is unfavourable as the thread could be pulled out.

If the TRX4S should be used with a different heatsink, you may use any flat surface. The position of the six M4 screws are arranged symmetrically on the 100x160 mm base panel, The distance from the long edge is 25,0 mm, from the short edge 20,0 mm and centre (80,0 mm).

Total disassembling the TRX4S

Better don't try to disassemble the TRX4S. Even for experienced technicians with a well equipped workbench it will be difficult to make repairs at the TRX4S. . Send the TRX4S to the manufacturer, where technicians with special knowledge of all secret tricks will care about your transceiver. Consider the risk of unintentional damage when trying to do repairs.

If it is necessary to disassemble the TRX4S, proceed as follows:

1. The heatsink may be removed or not.
2. Remove cover with speaker.
3. Remove all nuts of audio and squelch-pots and of all connectors.
4. Remove 7 screws at front and side and pull the U-shaped front panel gently towards you. The perforations in the front panel are etched with 0,05 mm precision and there is no margin. Take extreme care not to bend the panel. The corners of the U-shaped side panels must not be bent, otherwise the panel may break. Put the to a safe place.
5. Remove the remaining 3 screws on the rear side, poll the rear panel gently away. Do not bend!
6. The TRX4S must not be operated (transmit mode) without base panel. There exists the risk to overheat the power amplifier module. or the voltage regulator. . When adjusting the TRX4S, the influence of the base panel was considered (capacity and screening effect). With correct adjusted over-temperature protection, the TRX4S may be operated for tests without case at full power, as long as the base plate is correctly installed.
7. Replacing the power amplifier: Unsolder the 5 pins (remove all solder and pull wire gently up). Remove the two M4-screws of the module and pull it to the side out. If the module is too tight, loosen the M2,5 screws around the module. To reinstall the amplifier, execute the steps in reverse order. The pins of a new amplifier have to be cut to 5-6 mm. The mounting screws of the module must never protrude the base panel. Use adequate washers! Do not overtighten (Aluminium).
8. Disassembling the printed circuit board: Remove the voltage regulator and all 11 M2.5 screws. **Be extremely careful:** if the screwdriver slides out the screw's head, you will destroy the SMD components nearby. Finally take the board away from the panel. Take care not to loose the spacers.
9. Assembly in reverse order. Do not overtighten the screws. The voltage regulator has to be mounted using a mica insulating and washer. . First reinstall the rear panel and the front panel later. Finally, install the nuts on the connectors and potentiometers again.

Adjustment of the transmit power

There are 5 miniature trimmer for adjustment of transmit power. Be very careful when adjusting: you might damage the tiny components and the power amplifier by setting a too high power limit. The trimmer have no mechanical limit, it is difficult to recognise the position of the trimmer.

The trimmers are near the power amplifier. (see picture)

The transmit power was pre-set to 3-6-12-25 watt.

With low supply voltages (below 13 volt) the maximum power of 25 watt may be not reached.

There exists 5 trimmer resistors:

- R560 PWR max.: power limitation, max. power setting
- R557: PWR0: adjust step 1 power 1 (3 Watt), minimum transmit power
- R555: PWR1: adjust step 2 power (6 Watt)
- R554: PWR2: adjust step 3 power (12 Watt)
- R553: PWR3: adjust step 4 power (25 Watt)

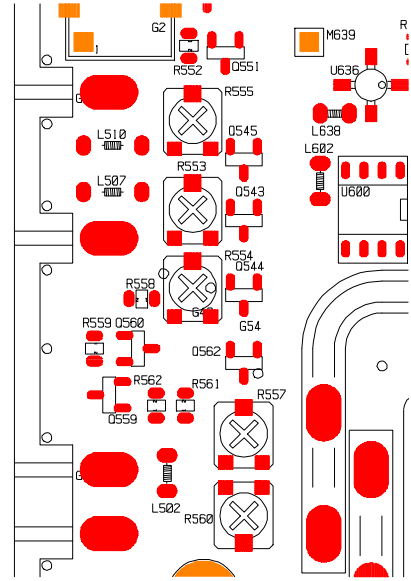
Adjustment transmit power:

Required: a power-meter (1 to 35 watt) with 50 Ω dummy load is connected to the antenna connector of TRX4S. Note: even short RG58 cables will cause a significant power drop due to attenuation.

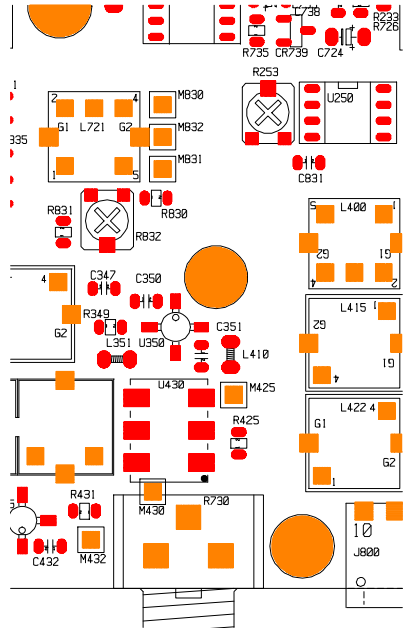
1. program the power to step 4 (25 Watt), key the transmitter an read the power-meter.
2. turn PWR3 (R555) to maximum clockwise position (min. resistance, max. power)
3. adjust PWR max. (R560) for a reading of 30 watt. Turning clockwise increases power. The setting will limit the output power and protect the amplifier. Avoid prolonged transmissions at powered above 25 watt.
4. program power step 1 (3 Watt), key the transmitter and adjust the power to 3 watt by turning trimmer PWR0 (R557). Clockwise rotation increases power.
5. program power step 2 (6 Watt), key the transmitter and adjust the power to 6 watt by turning trimmer PWR1 (R553).
6. program power step 3 (12 Watt), key the transmitter and adjust the power to 12 watt by turning trimmer PWR2 (R554).
7. program power step 4 (25 Watt), key the transmitter and adjust the power to 25 watt by turning trimmer PWR3 (R555).

R560 (PWR0) defines the lowest possible power at step 1 (3 watt). Power below 2-3 watt may be difficult to set. With step 2, 3 and 4 (6, 12, and 25 w) you may set any powers between 3 and 25 watt as desired, e.g. 3, 6, 9 and 18w. The output power is regulated and constant within 0.5 dB over the total frequency range of TRX4S transmitter.

The typical output power capability of the amplifier module used is 35 to 40 watt at 13,8 volt supply voltage. It is however possible to set the trimmers to get much more power as 25 watt. This results in excessive heating of the amplifier and may cause progressive reduction of the power capability or total failure after weeks or months of operation.



Position of TX-power trimmer



Audio

Adjusting of temperature limitation

Near the power amplifier module, you find a SOT23 miniature temperature sensor. Via the A/D converter the temperature of this sensor can be displayed by software. . Further, there exists a circuit, which will shut down the transmitter when overheated. If the PTT-input is pulled to ground and the red 'TX'-led doesn't light, check if there is a overheating condition. (If the transmitter is cold, an alternative cause might be that the PLL doesn't lock because of a wrong programmed frequency).

The temperature protection is set to 62 ± 2 C. When increasing this limit, there is a risk of overheating and damage. Especially the power amplifier module may be damaged by excessive temperature.

Inside the TRX4S you find a miniature trimmer for adjusting the maximum permissible temperature. . Be very careful when adjusting. The trimmer has no mechanical stop and the position cannot be recognised optically.

The trimmer R832 is located behind the audio and the squelch pot between two filters. (see picture)

Setting the temperature limit:

The temperature sensor is pre-calibrated. So, it is sufficient to measure the output voltage of the sensor to determine the temperature. For more precise adjustments, a oven would be required.

You need a high impedance voltmeter. Measure the voltage at Pin 2 of U250 (right top) or at the tap of trimmer R832 (left top). Adjust the following settings:

Temp. Max °C	Measure Volt
(20)	(2,81 V)
40	3,00 V
45	3,04 V
50	3,09 V
55	3,13 V
60	3,17 V
62,5	**3,19 V**
65	3,21 V
70	3,25 V
75	3,29 V
80	3,33 V

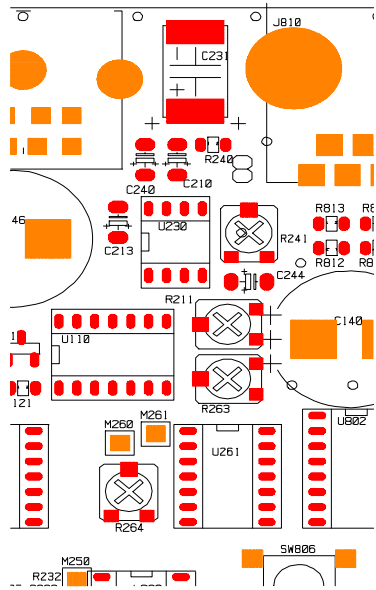
The precision achieved by this way of measurement is approx. 5° C. Theoretically, you may set the trimmer to voltages from 2,97 to 3,60 volt, which corresponds to a temperature range from 38 to 125 C.

Adjusting of rf carrier detection

The receiver-IC's of TRX4S have a RSSI-output (radio signal strength indicator), where you can measure a voltage, which is proportional to the rf input level (in dB). There exist two separate RSSI-signals, one for wide and one for narrow bandwidth signal reception.

If the RSSI-signal exceeds a pre-set level, the green 'RSSI-LED will light. Simultaneously, pin 6 of the 6-pin mini-DIN data-connector is pulled low.

With the trimmers R263 (DCD level narrow) and R264 (DCD level wide), the trigger voltage for carrier detect can be adjusted. separately for narrow and wide



mode. The trimmer can be found near the 6 pin mini-DIN connector inside the case.

Procedure: apply an unmodulated carrier with the desired strength to the antenna input and adjust the trimmer R263 (DCD level narrow) and R264 (DCD level wide) so, that the led just flickers. For adjusting DCD-level narrow you will have to select a frequency in narrow mode, equivalent for 'wide'-setting.

The setting does not influence the reception of data signals in any way. Only the function of the green DCD-led and the DCD-output (pin 6) is affected.

The adjustment range goes from 'permanent DCD' (ccw) to 'never DCD detect' (clockwise). Between the limits, the adjustment is approximately linear with the logarithm of the input power. The trigger point may be adjusted to any input signal strength within the dynamic range from –120 dBm = 0,2 µV to –50 dBm = 1 mV (narrow) or –115 dBm = 0,5 µV to –40 dBm = 2 mV (wide).

If the DCD is set to a very low level, the presence of additional noise (QRM, QRN) or the use of an preamplifier may increase the idle input signal level and cause a permanent DCD-display. Set the level to a higher level to consider the additional signal.

Adjustment of the modulation (deviation)

The audio input voltage (mini-DIN-connector pin 1) for appropriate deviation is set to 0,5 volt peak-peak. If your packet-radio-controller supplies more or less voltage, you should adjust the signal at the TNC but not at the TRX4S.

The modulation input sensitivity can be adjusted separately for narrow and wide mode. The adjustment range goes from few mV up to approx. 0,8 V_{pp} (narrow) or 3 V_{pp} (wide). Do not use too small signal levels in order to reduce additional noise.

The trimmers can be found behind the mini-DIN-connector (see picture)

For best setting in narrow mode, adjust R241 so, that you measure 0,6 V_{pp} at point M250.

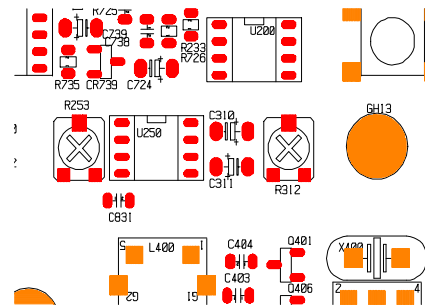
For best setting in wide mode, adjust R211 so, that you measure 4,0 V_{pp} at point M250.

Alternatively, you can use a test receiver with deviation-meter to set directly the correct deviation.

Note: too much input voltage causes excessive deviation on the transmit signal. This will cause problems due to distortion at the receiving station if the bandwidth of the receiver is smaller as those of the transmitted signal.

Adjustment of the modulation (compensation)

The transmitter of TRX4S is modulated using a two-point modulation circuit. The high frequency parts of the modulating signal is applied directly to the varicap diode of transmitter-VCO, the low frequency parts will also modulate the reference oscillator. So, it can be made sure, that the PLL does not compensate the low frequency parts of the input signal and that modulation down to very low audio frequencies is possible.

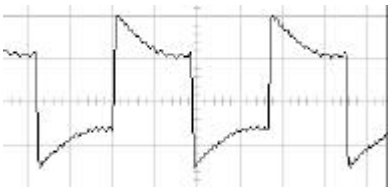


With trimmer R253 you may adjust the ratio of the two modulation indices for the two modulators. . You find it between the 7-segment-display and the audio volume potentiometer.

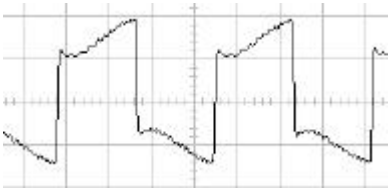
For adjustment, apply a square wave signal (0,5 V_{pp}) with approx. 150 Hz frequency to the data input of radio and watch the demodulated signal at the data output of a reference test receiver. (with appropriate bandwidth capability)

If the reference quartz modulation is not enough, (trimmer R253 turned too much ccw), you find a deviation from pulse flatness. After the pulse edge, the pulse of the received signal drops.

With too much modulation applied to the reference quartz, (trimmer R253 too far cw), you find



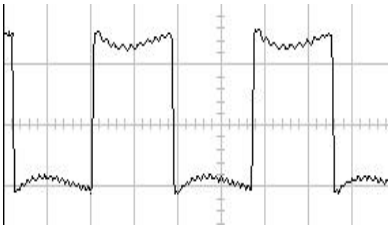
too little modulation of reference quartz



too much modulation of reference quartz

also a deviation from pulse flatness, but the voltage continues to rise slow after the edge.

If the compensation is adjusted properly, the rising and falling edges are at the same voltage level and the pulse top is not tilt.



Adjustment of the reference quartz

Transmit and receive frequency are derived from two quartz oscillators: the reference quartz determines the VCO-frequency, (approx. 350 MHz) and is primary responsible for precision of the transmit frequency. and stability. The 60,3 MHz oscillator participates also in generating the correct frequency.

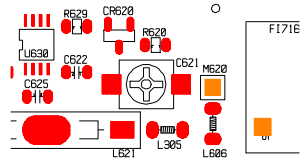
The frequency drift of the oscillators of TRX4S is approx. $2 \cdot 10^{-6}$. Adjustment makes only sense, is a frequency counter with a precision of $2 \cdot 10^{-7}$ or better is available. We recommend counters with temperature controlled quartz oven or counters with external synchronisation to a radio frequency standard (DCF77, WWV etc).

The frequency of the reference oscillator may be measured at pin 7 of the microcontroller IC or (without opening the case) at pin 9 of the REMOTE-connector. With trimmer R312 (see picture) the frequency may be adjusted to 12 800 000 Hz exactly. The TRX4S should be in receive mode and no modulation signal must be applied. Adjust the frequency to ± 1 Hz precision, which corresponds to 30-40 Hz error at 430 MHz operating frequency.

Alternatively, you may measure the frequency of one of the both VCO. Program any frequency (e.g. 435,000 MHz) and subtract the if frequency of 71,000 MHz. The resulting RX-VCO-frequency (e.g. 364,000 MHz) can be measured at M639 (behind the antenna connector, see picture 'output power adjust upper right).

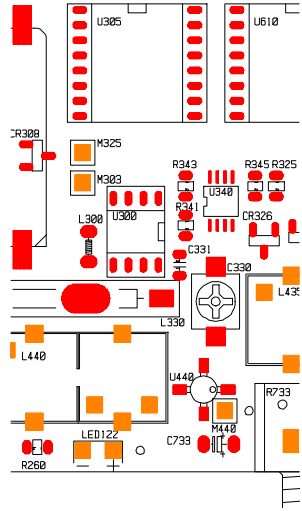
Do not adjust the reference oscillator by measuring the transmit frequency only, as this frequency depends on the precision of the other oscillator as well.

Adjustment of the local 60,3 MHz oscillator



After precisely adjusting the reference quartz to 12.8 MHz, you may adjust now the 60,3 MHz oscillator by measuring the transmitter output frequency. Tuning coil L400 (see picture 'compensation'), this oscillator frequency can be set within a narrow range to the correct reading. The 1,5-fold of the quartz frequency can be measured while transmitting at M425 (90,450 MHz). You find this point directly near the white transmit mixer, 10 mm behind the audio volume potentiometer.

Adjustment of TX-VCO

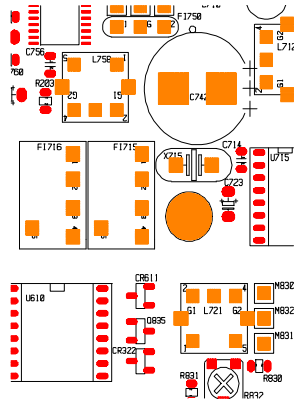


With a TX-VCO control voltage of 2,5 volt, the VCO should oscillate in the centre of the band. So, if the centre frequency is properly adjusted with C330 (at the end of the VCO-line, behind the squelch pot, see picture lower right) the voltage at M325 (see picture, middle left) will read 2,5 volt The transmitter may be disabled by miss-tuning L406 while measuring the VCO frequency.

Adjustment of RX-VCO

With a RX-VCO control voltage of 2,5 volt, the VCO should oscillate in the centre of the band. So, if the centre frequency is properly adjusted with C621 (at the end of the VCO-line, in the centre of the board, see picture upper) the voltage at M620 will read 2,5 volt.

Adjustment of quadrature coil



The coils L721 (narrow) and L750 (wide) are responsible for proper fm-demodulation. Adjustment is easy: connect an oscilloscope to the data output of the receiver and adjust for optimal symmetry of the receiver noise signal. The receiver input remains open or is terminated with a 50 Ω resistor.

If-filter adjust

We recommend not to do any adjustments at the if filters .

L710 and L711 are simply adjusted to maximum RSSI reading in narrow mode

The coils L665 and L682 have to be adjusted carefully. They are responsible for proper input and output matching of the 71 MHz quartz filter. Improper filter matching results in changing the amplitude and phase response of the filter, causing excessive distortion to the data signal. . With a suited sweeper you may

optimise the amplitude of the if filters, but not the phase response. It is a good idea to adjust the filter matching by observing the eye pattern at the receiver output. While receiving a 153 kbaud signal, you watch the eye pattern and adjust L665 and L682 for optimal symmetry and eye.

Adjustment of 90,45 MHz stages

The 60,3 MHz oscillator is set to the exact frequency by adjusting L400 (see above).

L406 is adjusted with the transmitter keyed up for sufficient drive of the frequency divider U410. If the coil is not adjusted, the divider doesn't work and there will be no 30,15 MHz signal present at the dividers output.

The 90,45 MHz is generated by tripling the 30,15 MHz at the output of the divider. At M425, the coils L420 and L422 are adjusted to maximum signal. The band filter at 90,45 MHz (L415 / L416) is set to maximum output too.

Adjustment of transmitter driver 435 MHz

The mixer U430 generates the 435 MHz transmit signal, which will be amplified to 0.5 watt in the 4 stage driver amplifier. The attenuators between the amplifiers make sure, that the amplifiers work absolutely stable with constant load and perfect matching.

For coarse adjustment, the power regulation of the power amplifier is disabled. If the regulation would be active, a change in driver power would be compensated by the regulation and you could not measure a difference when tuning the driver stages. Set the transmit power to level 4 (25 watt) and turn the corresponding trimmer R555 to maximum power. Now reduce the output again by setting the power limit (R560) to 5-10 watt output power at the antenna connector. Now, the power regulation is disabled. The value of the output is now proportional to the driver input and you can do the adjustments for the driver stages without problems. Be sure to set the trimmers to the old settings after the adjustment of driver.

Do not turn the brass screws of the helical filters. A readjustment is difficult. If all filters are tuned to maximum power at centre frequency, you will find a significant power drop at the ends of the band. Try to adjust the filters in a way to achieve flat response over the total frequency range but steep edges at the band limits. After the adjustment to maximum power at centre frequency, turn one of the three filters some MHz up and one some MHz down to get a flat response within the total frequency range and a sharp cut-off at the frequency limits.

Trimmers C455 and C467 are set to maximum output at centre frequency.

After successful coarse adjustment, re-set the power limit and regulation back to the previous value.

For fine adjustment of the amplifiers you won't need a wattmeter. If the power regulating trimmers are set to 3-6-12-25 watt with a limit at 30 watt, the measurement of the regulated bias supply of the driver stage in the module will do. Program the power range to level 2 or 3 (6 or 12 watt) and measure the voltage at the middle pin of IC U560 (voltage regulator at the base plate next to the amplifier module. The lower the voltage, the lower is the amplification of the driver to achieve the selected output level and the higher the driver stage power level. Adjust the drivers now to minimum reading of the regulated bias voltage at U560.

If the power regulation doesn't work stable at low power levels (3 watt), the driver power might be too high. Reduce driver power by setting the filters of the driver stages off resonance.

Adjustment of final amplifier and lowpass filter

The 5 coils L523, L528, L530, L532 and L545 are part of the 3 stage lowpass filter and the transmit-receive antenna switch. with the pin-diodes CR541, CR545 and CR528. Adjustment of these filters is not necessary. The attenuation of the filters in the pass band cannot be reduced. The harmonics of the transmitter are sufficiently suppressed and cannot be reduced by changing the filters.

The same is true for the coils L530 and L545 in the receiver input path.

Update of firmware

If it becomes necessary to change the firmware, stored in the microcontroller, gently pull the 18-pin IC U800 out of the socket and insert the controller with the new firmware.

Disabling the 7-segment display

The current drain of the 7-segment display is approximately 15 mA (the complete receiver needs approx. 250 mA). Directly in front of the display you find a jumper to disconnect the display power supply to save 15 mA.

Switching temperature / power reading

The microcontroller of TRX4S has two analogue inputs. One of them is used for measurement of the RSSI voltage, the other is normally used for reading the voltage across the temperature sensor, but can be set to power measurement as well.

Problem: you may read the temperature at any time. But measuring the transmit power makes only sense if the transmitter is keyed while measuring. As the PTT is controlled only by the attached packet-controller, which does not communicate with the TRX' microcontroller, measuring the real output power is difficult. For this reason, the default setting of TRX4S is temperature display.

With the default setting, S0=? will read the temperature of the amplifier. But it is possible to change the setting to power reading if necessary. Two steps are necessary:

1. The input of the A/D converter is connected to the temperature sensor by the jumper M830/M831 by a 100 kΩ miniature resistor. Remove the resistor (outer contacts of the 3 pin jumper) and connect M831 and M832 (middle contact and outer contact towards front) by the 100 kΩ resistor. Now, the A/D converter input is connected to the RF measurement rectifier. .

2. For temperature and power measurement calibration, there exists two different lookup tables in EEPROM.. Which of the two tables will be used when executing the S0=? command, depends on the value stored in address 0181H of EEPROM. This memory location is default set to 01H, the controller uses the table stored at the addresses 0400H to 04FFH to convert voltage into degree Celsius. If the jumper is changed to power measurement, the byte in 0181H has to be set to 00H using the 'POKE' command. Normally, the conversion table for power measurement is empty and has to be calibrated first.

Measuring points

For set-up and adjustment, the following measuring points can be used:

M100	+ 5 volt permanent
M101	+ 5 volt transmit
M102	+ 5 volt receive
M103	+ 12 volt fused, unregulated
M104	+ 10 volt permanent
M105	+ 4,8 volt low noise supply of VCO
M106	+ 5 volt permanent, input of t/r switching-FETs
M250	modulation after switchable low pass amplifier
M260	RSSI-signal from narrow demodulator
M261	RSSI-signal from wide demodulator
M303	PLL 12,8 MHz after prescaler (transmitter)
M325	VCO-control voltage (transmitter)
M425	90,45 MHz +3 dBm (transmit)
M430	TX-VCO 369,7-379,7 MHz +7 dBm
M432	TX-mixer output 430-440 MHz
M440	TX after first amplifier 430-440 MHz
M450	TX after second amplifier 430-440 MHz
M604	PLL after prescaler (receiver)
M620	VCO control voltage (receiver)
M639	RX-VCO 359-369 MHz +7 dBm
M747 / M746	connector for internal loudspeaker
M820 / M821	jumper for display supply
M830	temperature sensor output voltage
M831	A/D converter input for power or temperature measurement
M832	relative output power dc-voltage

Remote-Control connector

At the front, you find a 10-pin receptacle 'remote' to control all functions of TRX4S.

You need a 10 pin (1/10 inch or 2,5 mm spaced) male connector. A possible remote control unit may be attached to the front of the TRX4S by spacers with M2.5 screws, which fit into the base and cover plate threads and with 10 pins to connect the remote control jack.

The following signals are available:

Ground, + 5 volt, clock for power supply of a remote control unit

Pin 10 (oriented to centre of the front panel) is connected to ground, pin 8 supplies 5 volt from the internal voltage regulator of TRX4S. The maximum permissible current drawn is 150 mA.

The reference oscillator (12,800 MHz) is present at pin 9. Here you may attach a frequency counter for adjusting the transceiver frequency reference, but the buffered signal may be used for supplying a clock to an external processor of a remote control circuitry. A separate oscillator for such a circuit should be avoided, as this may cause additional interfering spectral lines within the receivers frequency range.

Push button functions 'up' and 'down' for channel selection

The signals for switching the channels up and down are accessible at the remote control connector pins 4 (down) and 5 (up). Note: the keys are not switched to ground but to + 5 volt!

3-wire interface for output of 7-segment-display, power-setting, mode

With every channel change, a 16-bit word is output at the three pins 1 (data), 2 (clock) and 3 (enable). Here, normally a shift register (serial in parallel out. e.g. 74HC595) is connected. After output of a hi or low signal at pin 1 (data), this information is shifted into the register by a low to high transition of the pin 2 (clock). After all 16 bit have been output in that way, the total information is latched with the rising edge of the pin 3 (enable) line. Now, all 16 bit are available at the parallel output of the shift registers.

Here the description of the 16 bit (shown in consecutive order first to last)

1. Bit	(not used)	9. Bit	7-segment: DP
2. Bit	(not used)	10. Bit	7-segment: g
3. Bit	(not used)	11. Bit	7-segment: f
4. Bit	(not used)	12. Bit	7-segment: e
5. Bit	power level 4	13. Bit	7-segment: d
6. Bit	power level 3	14. Bit	7-segment: c
7. Bit	power level 2	15. Bit	7-segment: b
8. Bit	mode narrow	16. Bit	7-segment: a

If only *one* 8-bit shift register is used, the bits 1 to 8 of the information are lost. The register will show only the last 8 bit (9 to 16) which can be used for a external 7-segment display. In most of the applications, the bits 1-8 are not necessary and may be omitted. A BCD to 7-segment decoder is not necessary, as the 7-segment patterns are stored in and generated by the microcontroller of TRX4S.

With bits 5 to 8 you may control LED's to display the current output power level and wide/narrow mode. The bits are sent with approx. 100 kbit/s in a synchronous mode (11.0 µs per bit). To built a simple decoder, you may copy the shift register circuit of TRX4S

serial asynchronous 9600 baud interface for programming etc.

Using pins 6 (serial output) and pin 7 (serial input), you can execute all commands of TRX4S as described on page 18. The interface is parallel to the external rs232-interface, but the signal levels are different. (voltages referred to pin 10, ground)

- serial output (pin 6): serial 9600 baud signal from TRX to remote control unit.
  Idle (stop bit): HI (5 volt), data (start bit): LO (0 Volt). 1 start bit, 1 stop bit.

- serial input (pin 7): serial 9600 baud signal from remote control unit to TRX4S.
  Idle (stop bit): HI (5 volt), data (start bit): LO (0 Volt). 1 start bit, 1 stop bit.
  For sending data, a open-collector output will do. The input is de-coupled to the external rs232 by a diode. Note: external programming via rs232 and programming via the remote control connector cannot be done simultaneously. If pin 7 is pulled to + 5 volt with a resistor (> 47 kΩ), the remote control unit can read the data, which is transferred from the rs232 to the TRX at the serial input of the TRX remote connector. In idle state, pin 7 must be open or pulled to + 5 V. If pulled to ground, the external rs232 programming won't be possible.

DETAILED CIRCUIT DESCRIPTION

We won't describe every stage of the circuit. Most of the TRX4S circuits are common amplifiers, filters or oscillators. We want to explain only those circuits, with special or unusual functions.

Reverse polarity protection: the safest protection against reverse polarity of the supply voltage would be a diode in series with the supply. As there would be a voltage drop of 0,3 to 0,7 volt, this solution would be unfavourable. We use a reverse biased parallel diode with 40 A current capability to blow the fuse. Using fuses with higher current rating results in the risk to blow the diode first and so destroying the transceiver when reversing supply voltage.

PTT-input: the PTT-input switches the transmitter via a 74HC132 Schmitt-trigger. As soon as the voltage at the PTT input drops below 2 Volt, the transceiver will switch to transmit, rising above 3 volt will switch to receive again. When not connected, there will be a voltage of + 5,0 volt at pin 3 of the data connector. The PTT-input is protected by a 200 kHz lowpass filter against rf interference. When keying the transceiver by an open-collector output, this low pass filter will cause a delay of the receive-transmit switching of approx. 5 µs, the switching from transmit to receive will take 50 µs. If the PTT is controlled directly by a ttl-output, the delay will be constant 5 µs in both cases.

Transmitter supply voltage: The 5 volt transmitter supply voltage is switched by a FET-switch with 5 amp current capability and a low R_{on} of 60 mΩ. The FET switches immediately. It would not be possible to have the switch before the voltage regulator, because the settling of the common 7805 regulators needs too long (about 1 ms and more). The transmitter supply is only switched on if the TX-PLL is locked. A unlocked PLL would oscillate on a undefined frequency and result in interference or unwanted transmissions. The led 'TX' lights if the TX is supplied with 5 volts and PLL is locked. The driver stages and the pin-diode antenna switch are not affected by the locking condition of the PLL. If the TX-frequency is programmed wrong, the PLL won't lock and remains disabled.

Receiver supply voltage: The receiver is switched on after transmission with a little delay to make sure, that the transmitter is totally shut of when reception starts again. As with the transmitter, the RX-supply is only switched on (green RX-led lights), when the RX-PLL is locked. If the RX-frequency is programmed wrong, the PLL won't lock and the receiver remains off.

Voltage regulator for PLL: The presence of noise on the LPL's supply voltage would result in excessive phase noise (unwanted modulation) of the transmitter and receiver output. For supply of the two PLL circuits, the normal voltage regulators are not suited. The TRX4S uses a simple transistor for filtering the noisy 5 volt internal supply. The transistor amplifies the voltage delivered from the 5 volt supply via a lowpass filter with 0,5 Hz corner frequency.

Power supply of the audio amplifier: The operational amplifiers of the modulation and audio stages are supplied symmetrically with +/- 5 volt. The internal +5 volt is used as the ground for the amplifiers, the transceiver ground is used for negative supply and a regulated voltage of 10 volt is used for positive supply. The +10 volt come from a standard 5 volt regulator with its ground pin connected to 5 volt. The regulated 10 volt will also supply the LM386 audio amplifier for the speaker.

Switchable 90,45 MHz oscillator: A stable oscillator needs approx. 10 ms to start oscillating or to lock on a frequency. Hence, all oscillators in a fast data transceiver have to oscillate permanently. The problem is, that the oscillators, needed for generation of the transmit frequency, will cause a spurious signal exactly at the receiver input frequency in simplex mode (f TX = f RX). The problem was solved by using a 'TXD-null-oscillator': The transmit frequency is generated by mixing of the constant PLL frequency with a 90,45 MHz auxiliary frequency, derived from a frequency divider with a fix 60,3 MHz quartz. By switching off the frequency divider, the 30,15 and the tripled 90,45 MHz signal vanishes completely, however, all quartz oscillators remain on. So, there exists really no spurious signal at the transmit = receiver frequency when receiving.

Diode mixers: The TRX4S uses two high quality diode mixers 'ADE13'. The local frequency input level is as high as +7 dBm = 5 mW to achieve excellent large signal capability of the receiver and a high level intercept point. (IP3: 17 dBm = 50 mW)

Amplifiers general: All rf amplifiers use monolithic amplifiers type ERA3. These amplifier IC are suited for up to 3 GHz, have a input and output impedance of 50 Ω, which makes matching easy. The gain of approx. 20 dB per amplifier is reduced by pi-attenuators between the stages to 14 to 17 dB to improve stability and matching of the amplifiers. With a noise figure of 3,8 dB, these amplifiers may be used as sensitive preamplifier as well, but more important is the excellent large-signal capability of these amplifiers. (IP3 = 23 dBm = 200 mW). The amplifiers may be driven with up to 20 mW (1 volt) rf at the antenna input without damage.

Power amplifier: As power amplifier, the Toshiba M57729 is used. According to the datasheet, it is capable to output 45 dBm = 35 watt rf power, typical values of much more have been measured. With 44 dBm = 25 watt transmitter output power, there is enough power margin to keep the output constant over the total frequency range. The harmonic frequencies, measured directly at the module output are 20 dB below the carrier (24 dBm = 0,3 W).

Lowpass output filter and antenna switch: The harmonic frequencies of the transmitter signal are suppressed by a lowpass filter. The attenuation of the first harmonic frequency at 870 MHz with a third order filter is approx. 60 dB. This gives a total suppression of 80 dB = -36 dBm = 250 µW referred to the carrier. The attenuation of the third harmonics is even better. In series with the transmit signal path, there is a high power pin diode, which disconnects the transmitter output from the antenna when receiving. The diode is suited for rf power up to 100 watt and has a rf-resistance of 0,5 Ω at 30 mA control current. The antenna signal passes a third order filter on its way to the receiver input. When transmitting, the rf from the transmitter is switched to ground with two pin-diodes. The high attenuation of this switch makes sure, that the receiver input is not overdriven or even damaged by the high power transmitter levels. In most transceivers, only one diode is used for keeping the transmitter power away from the receiver input, which results in a much stronger rf signal at the sensitive preamplifier input.

Transmit power regulation: Directly at the power amplifier module output, the rf is rectified by a capacitor and fast low-capacity Schottky diode. The rectified rf voltage is filtered and controls via a dc amplifier and a switchable voltage divider the reference input of a programmable voltage regulator LM317T, which supplies the drivers. When rf output power drops, the voltage across the divider decreases and the supply voltage of the drivers increases to give more power. With 4 trimmers, the voltage divider can be switched to program one of 4 pre-set power levels. When in receive mode, the voltage divider is pulled to +5 volt to shut down the driver supply completely.

VCO circuit: The VCO frequency is generated with a newly developed IC, giving a signal with perfect spectral purity at a high power level. For inductor, there is no coil used but a λ/4 semi-rigid-resonator. This avoids interference and acoustic-mechanical influences to the VCO tank circuit and has better temperature stability compared to wounded coils.

Data-output (demodulation): The outputs of the both demodulators (wide, narrow) are selected by an analogue switch to pin 4 of the data connector. When transmitting, both switches are open and the output is disabled. Pin 4 is dc decoupled by a 470 Ω resistor in series with a 22 µF capacitor. .

Data input (modulation): The data input (Pin 1) goes to two low pass amplifiers with different corner frequencies. for wide and narrow. The outputs are switched to the modulating circuits when transmitting. In receive mode, the modulation is disabled. Otherwise, the reference oscillator, which is used for reception too, would be affected by the data in signal, causing interference to the receive data.

Squelch: The AF-noise of the narrow demodulator is filtered at 11 kHz and rectified with CR739. If the noise amplitude exceeds a certain value, which can be set with the squelch pot R733, the audio signal is switched to ground by an analogue switch.

Audio-amplifier: The control speaker is driven by the amplifier IC LM386. With 10 volt supply voltage this amplifier delivers 0,7 Watt into a 8 Ω load. The built-in speaker is disconnected if an external speaker jack is plugged-in.

Comparator for rf-DCD: The RSSI-signals of the two receivers are compared to an adjustable dc voltage (trigger level). The output of one of the comparators controls only the green led 'RSSI-DCD', the other is the pin 6 of the data connector. The trimmer for setting the DCD trigger and the RSSI-outputs of the if amplifiers are switched by analogue switches.

A/D converter for RSSI, temperature and power measurement: The microcontroller possesses two analogue compactor inputs. One of the comparators is used for RSSI measurement, the other for temperature or power measurement. The non inverting input of the comparators is connected to a 22 nF capacitor, which is charged to +10V by a 100 kΩ resistor within 2 ms time. The capacitor is discharged by a FET to zero volts and the microcontroller measures the charge-time, which is needed until the voltage across the capacitor becomes equal to the voltage to be measured The time is measured as a value within the range between 1 and 255 and converted by a lookup-table in to the displayed value. (dBm. °C)

RS232-interface: the UART (asynchronous transmitting and receiving) is performed by software in the microcontroller. The baudrate (9600 baud, 1 start, 1 stop bit, no parity) is fixed and cannot be changed. For level translator, the well known MAX232A is used. With its built-in charge pump, this driver generates the +/- 10 volt. The serial input and output is filtered with a r-c-r lowpass filter to reduce rf interference with the serial interface connector. The rs232-input is pulled to -10v with a 10 kΩ resistor to give a 'low' signal (stop bit polarity) when no computer is connected. This is important to control the TRX4S controller via the external rs232 interface parallel to the remote control connector. As the charge pump of the MAX232 uses high current and high frequency pulses for generating the +/- 10 volt, the 5 volt supply of the MAX232 is decoupled from the transceiver by a 10 kHz lowpass filter.

Temperature sensor and over-temperature protect: At the power amplifier module's mounting screw, there is a tiny KTY92 temperature sensor with a nominal resistance of 2000 Ω at 25 °C. The temperature coefficient of this semiconductor sensor is $7{,}9 * 10^{-3}\ K^{-1}$. Hence, at 70 °C the resistance increases to 2780 Ω, the voltage across the voltage divider R830 – U830 rises accordingly. As soon as the voltage reaches the value, set by trimmer R832, the op amp U250 pulls the transmit enable signal to ground via transistor Q835 and disables the transmitter immediately. After cooling down, the transmitter returns back to normal operation.

Channel display: The channel number is displayed by a 7-segment-display TDSR3160 (common cathode). With 1,5 kΩ segment resistors the total current is 4 to 16 mA depending on the figure displayed. The display is controlled by a 8 bit serial-parallel-converter (shift register), the 7-segment-code is stored in the microcontroller firmware.

EEPROM: The 8 pin SMD-EEPROM has a storage capability of 16 k Bit = 2048 byte. The addresses from 0000H to 017FH are used for storing the 16 frequency records, 0200H to 03FFH contains the

lookup tables for measuring conversion. The EEPROM is accessed by a 2-wire interface. The firmware allows to read from and write to any address by the PEEK and POKE commands.

REGULATIONS, ETC.

All copyrights on firmware, PCB-layout and schematics of TRX4S are reserved to SYMEK GmbH or Ing. Büro Kumm, Stuttgart. Parts of the circuit are covered by patents pending.

Parts of this manual may be published if there is a reference in the bibliography. It is our concern to contribute to packet-radio by offering new and powerful equipment and to inspire many radio amateurs by this fascinating technique

When properly used, the TRX4S complies with the regulations of German EMVG and bears the CE-sign. A German BZT-approval, which would be necessary for commercial use does not exist. So, the use of the transceiver is limited to licensed amateur radio operators as transmitter.

The user will need special knowledge on electronics and communication techniques for operating the transceiver, as it is demanded to pass the amateur operators licence exam. The transceiver and the description are not made to be used by people without technical knowledge. .

For proper use, it is necessary to connect the transceiver to a suited power supply, to connect a suited signal source for modulation, which meets the requirements described in this manual. , to connect a suited antenna with according feeding cables. For not to deteriorate the EMV-values, you must connect only those subassemblies to the remote-control connector, which are recommended by the manufacturer. additional modules have to be connected using the original connectors. Make sure, that the cables connected are not interfered by strong electro-magnetical fields (speaker, modulation, power supply, antenna).

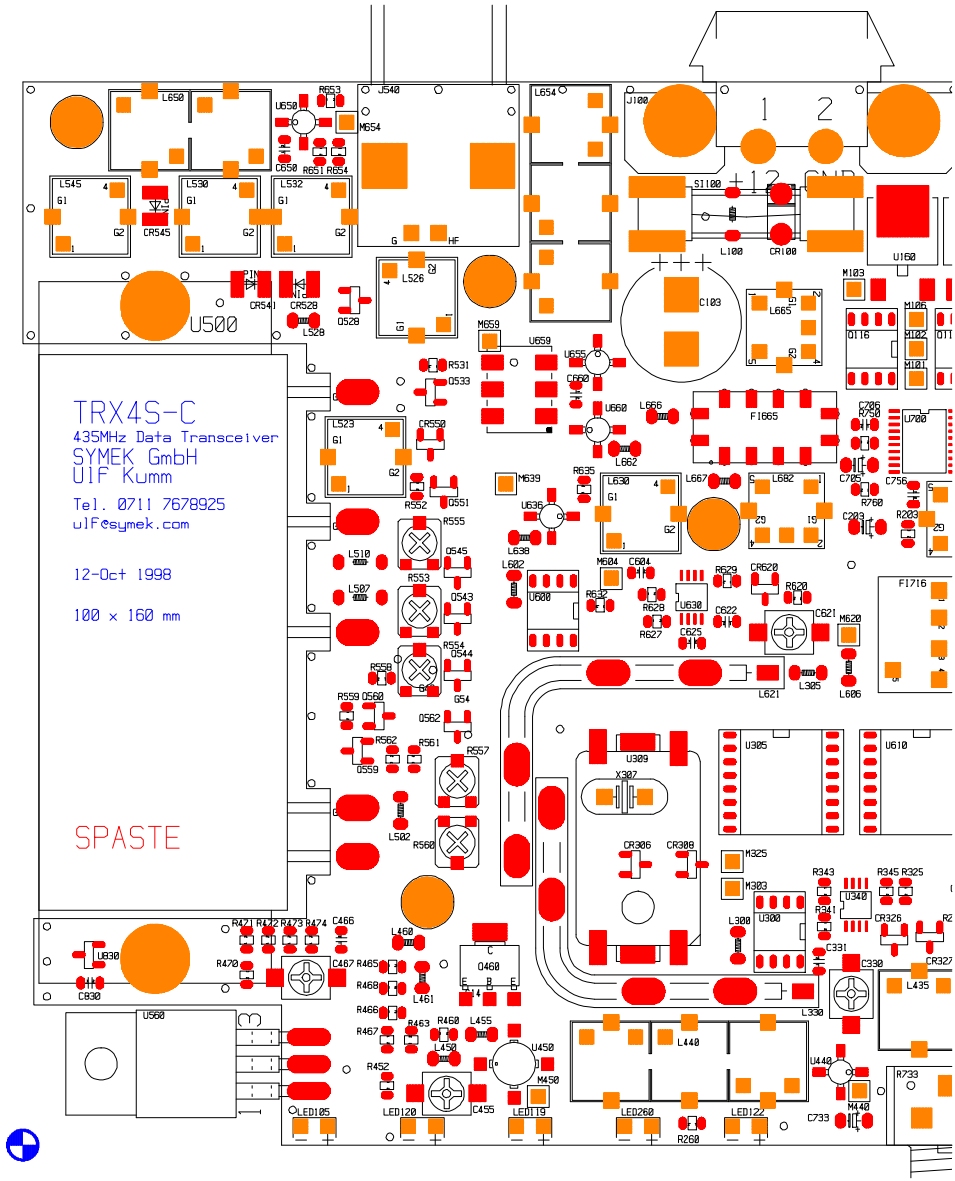
The user is - as with any other amateur radio transmitter - obliged to make sure, that no person is endangered by the radio frequency power, produced by the transmitter. If you are not sure about the existing regulations for operating a transmitter or high frequency equipment, see your local authorities for telecommunications. For Germany, see the information published by Regulierungsbehörde für Post und Telekommunikation (http://www.regtp.de).

The actual German law allows everybody to own or trade with the TRX4S transceiver. This is also true for using the TRX4S as receiver only. . If used as transmitter, the responsible user has to have a permission (e.g. amateur radio operators licence).

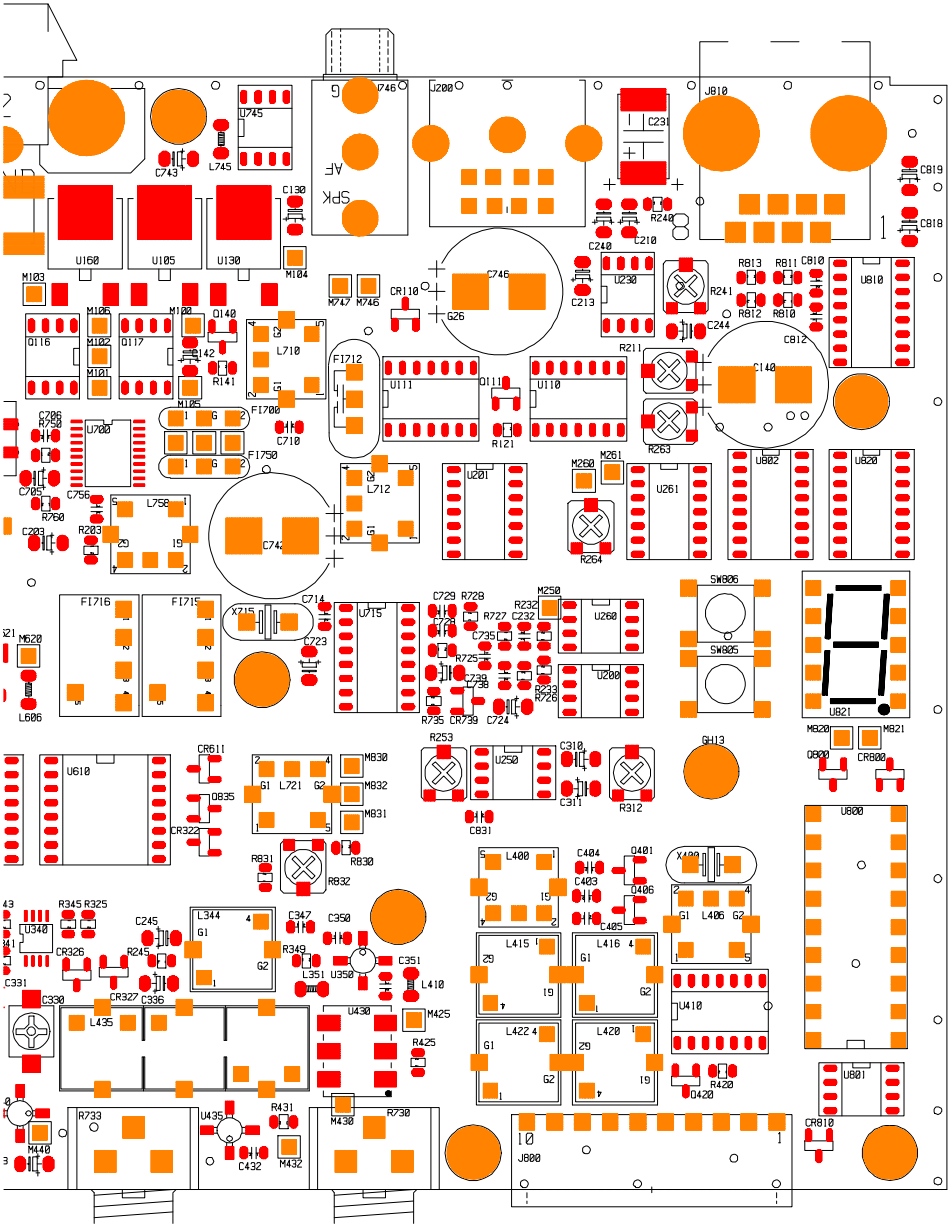
We are nor liable for any damage, which might be caused by the use of the transceiver, nor for erroneous information or misprints in the manual.

SCHEMATICS, PART LOCATION

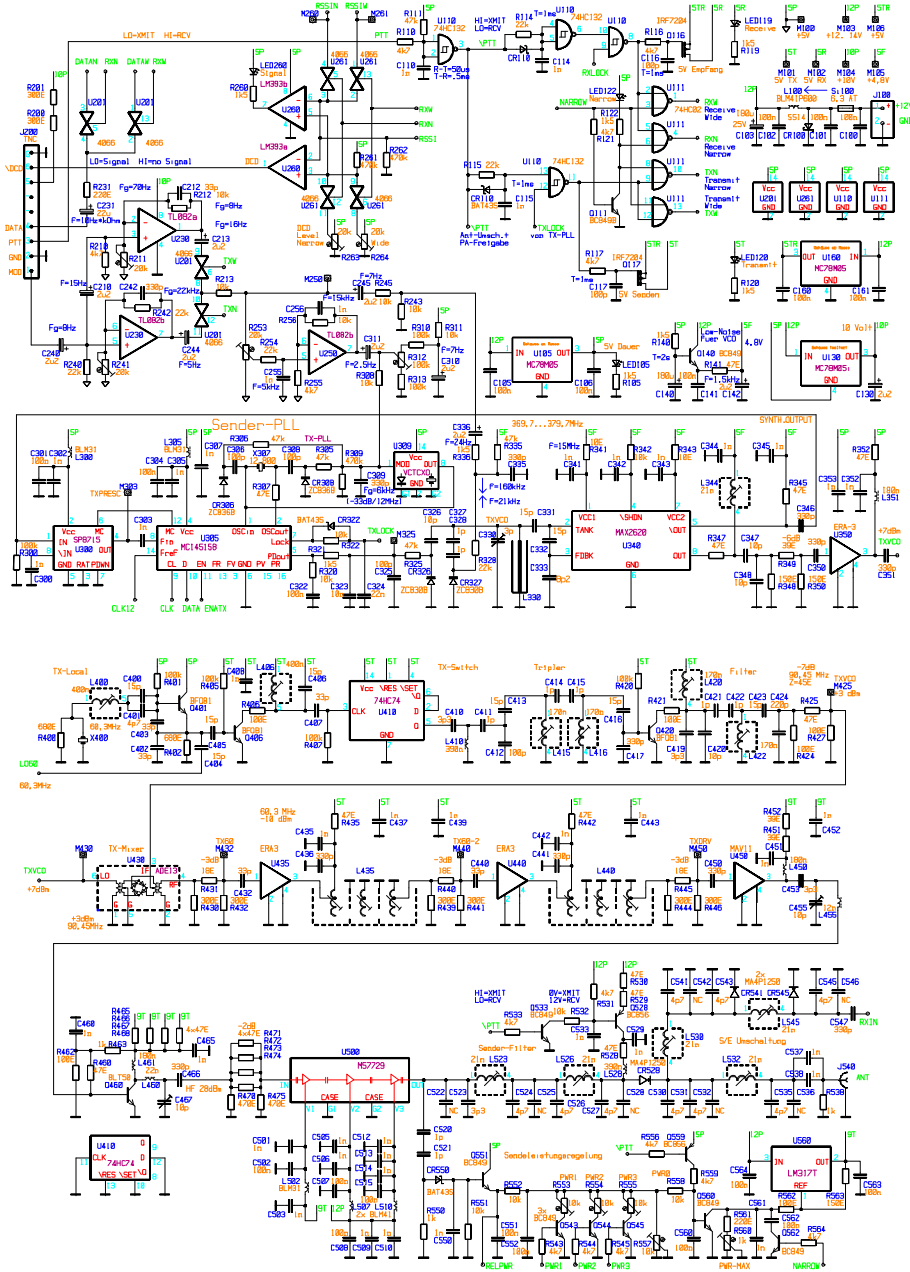
Location of the parts (left half)



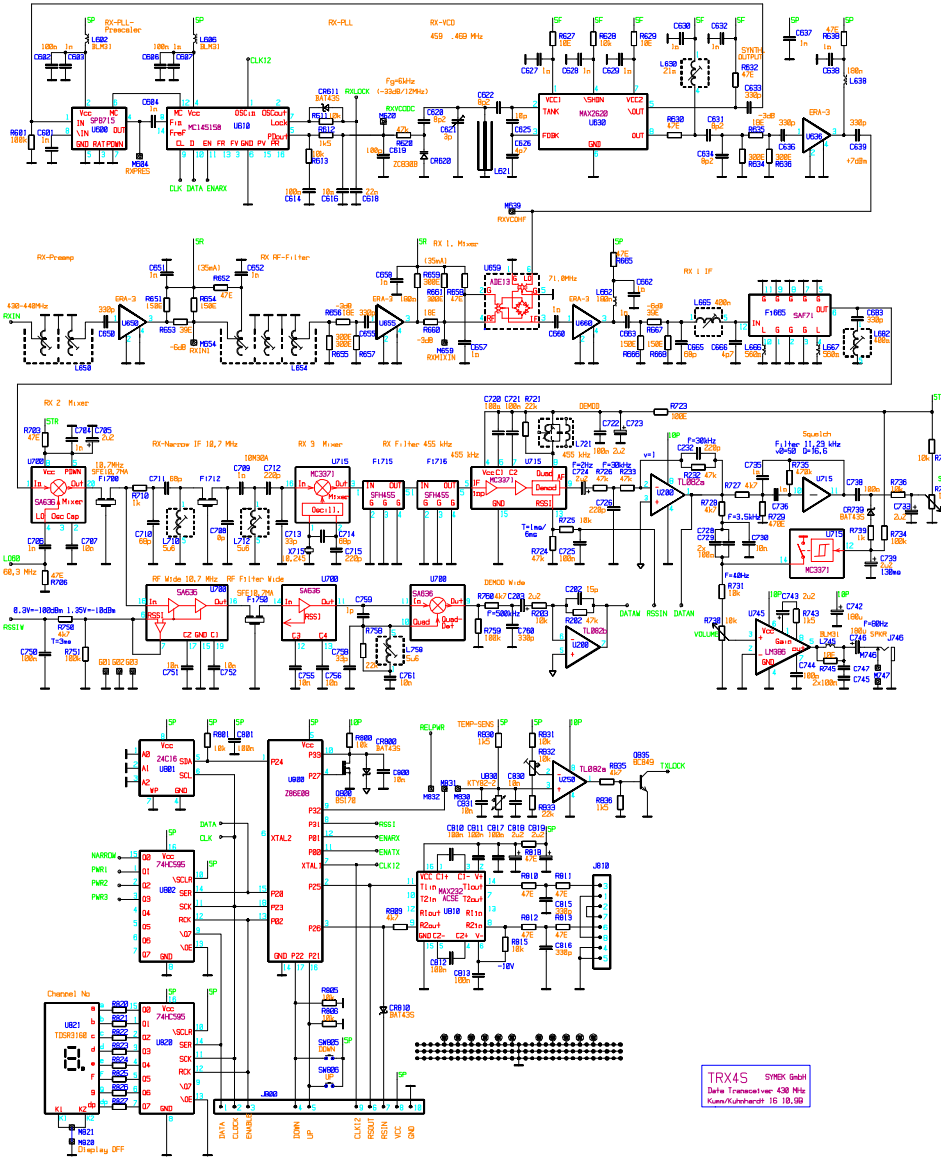
Location of the parts (right half)



Schematics TRX4S (AF, TX, power-supply)



Schematics (receiver, control)



WHAT TO DO IF THE TRX4S DOES NOT WORK?

Here some common user errors: :

Malfunction: PTT is keyed but the red 'TX'-led remains off. No transmit power.
Cause: wrong transmit frequency programmed or amplifier too hot.

Malfunction: 'RX'-led remains off, no reception
Cause: wrong receive frequency programmed.

The TRX4S design is proven good. The components are reliable for industrial use, the printed circuit board is of first class quality and all transceivers are tested thoroughly. However, there is a chance that the equipment would fail.

If you have done any modifications with TRX4S, please make sure that these modifications are NOT the cause for the malfunction and remove all modifications again. If there are changes or attempts to repair made, the warranty claim is void.

For the following damage there is no claim for warranty repair:

- Overload of power supply by over-voltage (over 16 volt), causing failure of the voltage regulator or the power amplifier module.
- Destruction caused by reverse polarity of power supply or by use of a wrong fuse.
- Destruction of the power amplifier, caused by misadjusted over-temperature protection or use of unsuited rf load (e.g. open antenna connector), bad SWR)
- Too high input level at receiver input, damage of the preamplifier
- Destruction of serial interface caused by over-voltage at the rs232-connector
- Destruction of the audio signal amplifiers caused by over-voltage at the data-connector
- Destruction of the audio power amplifier caused by over-voltage or short circuit at the speaker connector
- Destruction of components caused by over-voltage at the REMOTE-connector.
- Any kind of mechanical damage

The warranty period is 1 year from purchase, excluded are damages caused by the customer.

Please give us a **detailed description** of the failure and what has happened before the failure occurred. The repair could be done faster and more easy.

We hope, you enjoy the use of the TRX4S high speed data transceiver.

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CONVERSION VOLT, WATT, DBM

U	P (50 Ω)	dB (µV)	dBm	S-Meter
0.05 µV	50E-18 W	-26 dB (µV)	-133 dBm	S 0 –6 dB
0.1 µV	200E-18 W	-20 dB (µV)	-127 dBm	**S 0**
0.2 µV	800E-18 W	-14 dB (µV)	-121 dBm	S 1
0.5 µV	5E-15 W	-6 dB (µV)	-113 dBm	S 2,3
1 µV	**20E-15 W**	**0 dB (µV)**	**-107 dBm**	S 3,3
2 µV	80E-15 W	6 dB (µV)	-101 dBm	S 4,3
5 µV	500E-15 W	14 dB (µV)	-93 dBm	S 5,6
10 µV	2E-12 W	20 dB (µV)	-87 dBm	S 6,6
20 µV	8E-12 W	26 dB (µV)	-81 dBm	S 7,6
50 µV	50E-11 W	34 dB (µV)	-73 dBm	**S 9**
100 µV	200E-10 W	40 dB (µV)	-67 dBm	S9 +6 dB
200 µV	800E-10 W	46 dB (µV)	-61 dBm	S9 +12 dB
500 µV	5E-9 W	34 dB (µV)	-53 dBm	S9 +20 dB
1 mV	**20E-09 W**	**40 dB (µV)**	**-47 dBm**	S9 +26 dB
2 mV	80E-09 W	66 dB (µV)	-41 dBm	S9 +32 dB
5 mV	500E–9 W	74 dB (µV)	-33 dBm	S9 +40 dB
10 mV	2E-6 W	80 dB (µV)	-27 dBm	S9 +46 dB
20 mV	8E-6 W	86 dB (µV)	-21 dBm	S9 +52 dB
50 mV	50E-6 W	94 dB (µV)	-13 dBm	S9 +60 dB
100 mV	0,2 mW	100 dB (µV)	-7 dBm	S9 +66 dB
200 mV	0,8 mW	106 dB (µV)	-1 dBm	S9 +72 dB
224 mV	**1 mW**	**107 dB (µV)**	**0 dBm**	S9 +80 dB
0,5 V	5 mW	114 dB (µV)	7 dBm	
1 V	20 mW	120 dB (µV)	13 dBm	
2 V	80 mW	126 dB (µV)	19 dBm	
5 V	0,5 W	134 dB (µV)	27 dBm	
7,1 V	1 W	137 dB (µV)	30 dBm	
10,0 V	2 W	140 dB (µV)	33 dBm	
14,1 V	4 W	143 dB (µV)	36 dBm	
17,3 V	6 W	145 dB (µV)	38 dBm	
20,0 V	8 W	146 dB (µV)	39 dBm	
22,4 V	10 W	147 dB (µV)	40 dBm	
24,5 V	12 W	148 dB (µV)	41 dBm	
31,6 V	20 W	150 dB (µV)	43 dBm	
35,4 V	25 W	151 dB (µV)	44 dBm	
50,0 V	50 W	154 dB (µV)	47 dBm	
70,7 V	100 W	157 dB (µV)	50 dBm	

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